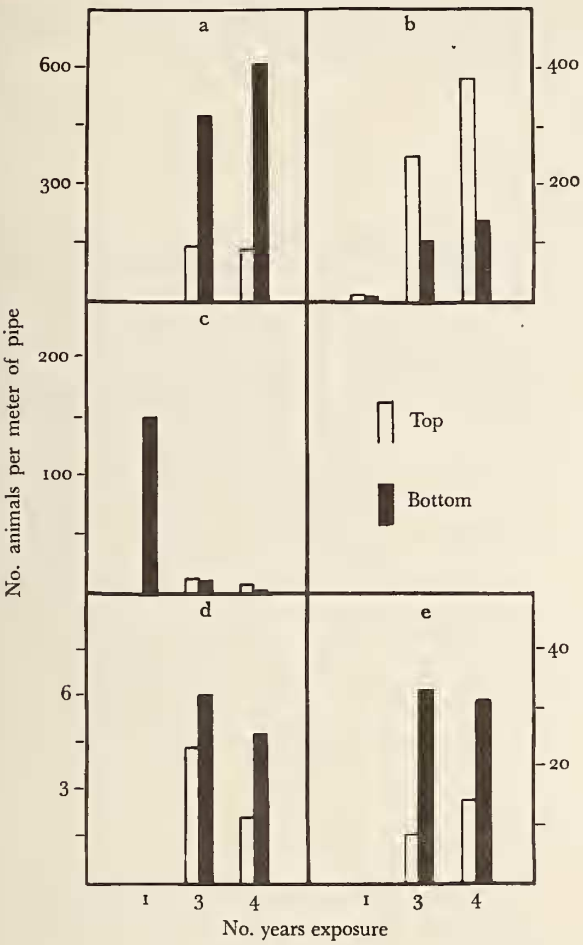


Figure 3

Number of animals, top and bottom, in the 5 cm horizontal pipe (a) *Hiatella arctica* (b) *Mytilus edulis* (c) *Molgula* sp. (d) *Anomia simplex* (e) *Balanus balanoides*

The 'A' frame water tables in each laboratory are fed by 2.5 cm diameter horizontal and vertical pipes. Fouling was heavier in the horizontal section; however, it was much lighter compared to the 5 cm horizontal pipes in the same laboratories. Dominant organisms were *Leucosolenia* sp., *Spirorbis spirillum* and ectoprocts, together with a few *Anomia simplex, Mytilus edulis* and *Balanus balanoides*. Stopcock valves located on horizontal pipes on the 'A' frames had to be unplugged frequently to maintain a flow of water through them. X-rays revealed that blockages were due to bivalve shells in the 'well' of the valves (Figure 5). These loose shells and debris washed down from the larger pipes, tended to block any valves which were not fully open.

Throughout the pipes, x-rays showed fouling was usually heavier near cracks or joints formed by corners, tees, and unions, than on neighbouring smooth surfaces.

Observations on the clear acrylic piping revealed the presence of air bubbles in the pipe system, the actions of which may have played an important role in settlement and distribution of foulers. The bubbles were constantly moving along the pipes, possibly introduced by the pump action or aeration of the water at the reservoir. Large air pockets collected at high points in the pipes. In horizontal pipes the bubbles moved along the top. In vertical down flow pipes they caused frothing as they tried to rise against the flow of water. As in the PVC pipes, a brown slime film was the initial life form observed. In the horizontal section of the acrylic pipe *Molgula* sp. located on the bottom of the pipe, was was the initial macrofouler. *Nicolea venustula* and then *Spirorbis* spp. were observed shortly after, followed by the sponges *Scypha* sp. and *Leucosolenia* sp. The vertical upflow pipes collected *Spirorbis* sp. and *Leucosolenia* sp. The vertical downflow pipes collected nothing but the slime film.

DISCUSSION

The hard substrate, enclosed space and relatively constant current within the pipes made them a suitable location for a number of sessile filter feeders such as sponges, bivalves, barnacles, and tunicates.

Great differences in fouling intensity were noted at various locations within the pipes. These seem to be related to a combination of water flows and pipe characteristics.

It is known that high water velocities limit settlement and stunts growth (Smith 1946). No fouling growth was found in those pipes where water velocities continuously exceeded 40 m per minute. Neither did water velocities below 10 m per minute or intermittent flows favour growth. These minimum flows may not replenish oxygen or planktonic food, or remove toxic metabolic wastes at a fast enough rate. Stagnation would kill whatever growth was present and require any succession to start over.

The optimum velocity for growth in the pipes was approximately 20 m per minute and a continuous flow over a considerable length of time produced the most intense growth.

In the straight sections of pipe, fouling was usually more intense in horizontal than the corresponding vertical pipes and in vertical downflowing pipes than vertical upflow pipes. The frequency of species also varied on the top and bottom half of a horizontal pipe (Figure 3). This may have been due to factors such as air bubbles, positive geotropism, deposits of mud and debris, interspecific competition or flow pattern of water.

The sieve end pipes, joints, tees, etc., which generally experienced heavier fouling, would disrupt water flow patterns and set up zones of turbulence and eddies. Such an area could offer a more suitable water velocity to settling animals. It is also known that some juvenile forms are stimulated to settle in crevices (HUNTER, 1949), such as were found at every joint.

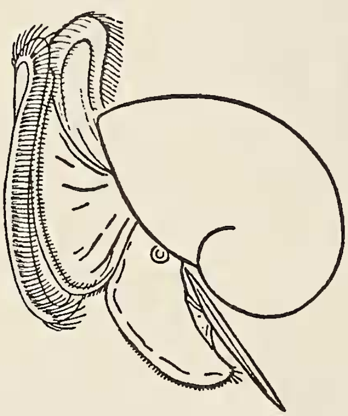
Significant differences in species density and diversity were noted between the pipes exposed for one summer season and the pipes exposed for 3 or 4 summer seasons. The older pipes were dominated by *Hiatella arctica* and *Mytilus edulis,* while the younger pipes contained mainly *Molgula* sp. and *Nicolea venustula.*

Literature Cited

DEPALMA, JOHN R.
1969. Marine biofouling at Penobscot Bay, Maine, and Placentia Sound, Newfoundland. Informal Reprt. No. IR 69-56, U. S. Naval Oceanographic Office, Washington, D. C. 14 pp.

HUNTER, W. R.
1949. The structure and behavior of *Hiatella gallicana* Lamarck and *H. arctica* L. with special reference to the boring habit. Roy. Soc. Edinburgh, Proc., Sect. B, 63 (3): 271 - 289

SMITH, F. G. W.
1946. Effect of water currents upon the attachment and growth of barnacles. Biol. Bull. 90 (1): 51 - 70



Hemphillia pantherina, A New Arionid Slug from Washington

BY

BRANLEY A. BRANSON

Eastern Kentucky University, Richmond, Kentucky 40475

(1 Text figure)

DURING AN EXTENDED collecting trip in Washington's North Cascade Mountains during the summer of 1973, I secured a single specimen of a very striking and apparently undescribed species of *Hemphillia*. Although the description of new species from single specimens is often a risky business, this form is so singularly different from any of the other known species that its description seems warranted.

In a previous work (BRANSON, 1972), I inadvertently overlooked an important paper by KOZLOFF & VANCE (1958) which detailed the status of *Hemphillia malonei* Pilsbry. Consequently, in order to assemble all known species in one place, the following key is presented.

KEY TO SPECIES OF *Hemphillia*

1 a. Body immediately behind pouch depressed to receive visceral mass, then producing a high, much-compressed keel 2

b. Body behind pouch neither depressed nor produced into a keel 4

2 a. Mantle covering at least sides of visceral pouch posteriorly; tail with "horn" lacking or only a small one present 3

b. Mantle not covering posterior one-third of visceral pouch; tail with a large, distinct "horn" above meeting of pedal grooves .... *Hemphillia pantherina* Branson, spec. nov.

3 a. Visceral pouch bearing numerous papillae; penial stimulator rugose within .... *Hemphillia glandulosa* (Bland & Binney, 1872)

b. Visceral pouch nearly smooth; penial stimulator smooth within ... *Hemphillia burringtoni* Pilsbry, 1948

4 a. Penis narrow, with an accessory sac; color yellowish-gray to whitish with dark markings .... *Hemphillia danielsi* Vanatta, 1914

b. Penis broad, lacking an accessory sac; color ashy-gray, bluish-black to black 5

5 a. Tail with a conspicuous horn-like protuberance above meeting of pedal grooves .... *Hemphillia dromedarius* Branson, 1972

b. Tail lacking a conspicuous horn-like protuberance above meeting of pedal grooves 6

6 a. Sperm duct opening within epiphallus into penis on side near base of verge attachment; penial retractor attachment partially to upper end of penis, partially to epiphallus .... *Hemphillia malonei* Pilsbry, 1917

b. Sperm duct opening within epiphallus into penis near end of verge; penial retractor attachment to epiphallus only .... *Hemphillia camelus* Pilsbry & Vanatta, 1897

Hemphillia pantherina Branson, spec. nov.

(Figure 1)

Head and tentacles white dorsally, pale gray ventrally. The heavily granulose mantle, which covers only the anterior $\frac{2}{3}$ of the visceral pouch and only the lower sides of the shell, is basically off-white in coloration and is unmarked along the lower margins; the dorsal $\frac{2}{3}$ is marbled by discrete, large stellate concentrations of melanin. A small pneumostome opens near the middle of the mantle on the right side, above and behind which is a black streak. The visceral pouch is smooth, colorless on the left half (appears dark brownish-gray because of the digestive gland showing through) but finely stippled with black on the right half. The secretory groove is indistinct on the midline, *i. e.*, on the posterior $\frac{1}{2}$ of the pouch. The anterior $\frac{1}{2}$ of the sides of the body are unmarked white except for 2 dark gray spots near the pedal groove; the posterior $\frac{1}{2}$ has 26 large, cell-like granules outlined by black. Posteriorly, the dorsum is dusky near the midline, but the high keel is bold white. The "horn" is dark gray, and there are dark gray spots between the granules immediately above

[1] Supported in part by a Sigma Xi-Resa grant; in part by an Eastern Kentucky University faculty grant

the pedal groove on the posterior $\frac{1}{2}$ of the body. The body is strongly depressed to receive the visceral pouch, but then becomes raised and strongly compressed to produce a high keel. A strongly developed, large triangular horn-

Figure 1

Hemphillia pantherina Branson, spec. nov.

like process is produced above the posterior meeting of the pedal grooves (above the genital pore). The pale yellowish shell (appears bi-colored because the digestive gland shows through) has a short, black bar near its center; there are numerous, indistinct growth striae.

Measurements (on alcohol-preserved specimen): total length, 14.2 mm; maximum width of foot, 3.0 mm; distance from posterior tip of visceral pouch to pneumostome, 5.0 mm; length of back posterior to visceral pouch, 4.3 mm; width of visceral pouch, 4.5 mm; length of visceral pouch, 9.5 mm; width of back behind pouch, 3.5 mm; maximum width of shell, 3.5 mm; maximum length of shell, 6.0 mm; distance from anterior end of mantle to pneumostome, 4.8 mm.

Type Locality: S 31, T 7 N, R 6 E, Route N 90, Miller Creek crossing, Gifford Pinchot National Forest, Washington. Beneath deep forest litter. 9 July 1973

Holotype: Delaware Museum of Natural History, DM NH 85722

Diagnosis: *Hemphillia pantherina* is an arionid slug which differs from all known species of the genus by the characteristics of the mantle and visceral pouch relationships. It is most closely related to *H. burringtoni* Pilsbry by way of color pattern, but differs from that species in having a granulose mantle, in having the pneumostome near the middle of the mantle rather than in the posterior $\frac{1}{3}$, and in possessing a large horn-like process posteriorly rather than a small one.

Literature Cited

Branson, Branley A.
1972. *Hemphillia dromedarius*, a new arionid slug from Washington. The Nautilus 85: 100 - 106

Kozloff, Eugene Nicholas & Joann Vance
1958. Systematic status of *Hemphillia malonei*. The Nautilus 72 (2): 42 - 49; plt. 6